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A JOB ANALYSIS OF THE AEGIS COMBAT SYSTEM SUBMODES.(U)

JAN 82 R C CARTER, M PATSFALL, R H SHANNON

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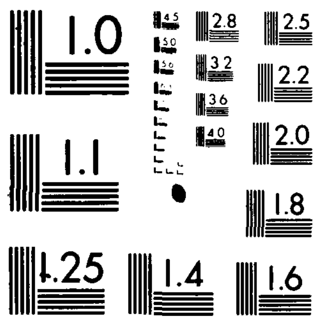

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A Job Analysis of the Aegis Combat System Submodes

Robert C. Carter, Michael Patsfall, and Richard H. Shannon

January 1982

NAVAL BIODYNAMICS LABORATORY
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ABSTRACT (Block 20) Continued

verbal orders/instruction/requests, preceded by use of visual displays or decision making without reference to an external information source. Educational requirements for submode operation were a high-school education, on the average. Training time was extremely variable with a mean of about eight weeks. About 10 hours of study per month was perceived to be necessary to maintain proficiency in operating procedures, doctrine, etc.

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SUMMARY PAGE

PROBLEM

A question of frequent interest to the military is whether some aspect of the environment (e.g., high altitude, extreme temperature, undersea compression, vibration, ship motion) affects human performance capability. However, only those capabilities required by military jobs are relevant to the question. Hence, a problem which must be solved before the question can be answered is to find out what capabilities are required by military jobs to be performed in unusual military environments.

FINDINGS

A job-analysis questionnaire was responded to by 16 incumbent Aegis combat system submode operators. Their responses were the basis for analyses related to commonality among submodes, job elements, and sequences typical of submode operation, and the educational and training requirements of the submodes. It is concluded that there is considerable commonality among the submodes. Job elements typical of submode operation involve capabilities for communication, alert watchstanding, and attending to detail while working under distractions. Capabilities for writing, use of mathematics, and reasoning were reported to be relatively unimportant for submode operation. Typical sequences of job elements end with use of activation controls (e.g., VAB), or verbal orders/instruction/requests, preceded by the use of visual displays or decision making without reference to an external information source. Educational requirements for submode operation were a high-school education, on the average. Perceived training time required was extremely variable with a mean of about eight weeks. About 10 hours of study per month was perceived to be necessary to maintain proficiency in operating procedures, doctrine, etc.

RECOMMENDATIONS

Use tests of communication, alert watchstanding, and attending to detail while working under distractions and de-emphasize tests of writing, mathematics, and reasoning in experiments intended to be applied to AEGIS-like military jobs.

The work was funded by the Naval Medical Research and Development Command.

The volunteers used in this study were recruited, evaluated, and employed in accordance with the procedures specified in the Secretary of the Navy Instruction 3900.39 series and the Bureau of Medicine and Surgery Instruction 3900.6 series. These instructions are based upon voluntary consent, and meet or exceed the provisions of prevailing national and international guidelines.

INTRODUCTION

This is the report of a job analysis of the Aegis Combat System submode operator's job. Job analysis is the process of obtaining and summarizing job-related information that can be used as a basis for equipment design, personnel placement, training, or remuneration. The Aegis Combat System is a recent improvement of the traditional Navy combat information center, which has the function of detecting, tracking, identifying, and (if necessary) engaging man-made objects within range of its sensors. The Aegis Combat System includes several operator work stations called submodes. Ostensibly, the submodes are quite similar, although each has a different specialized function. One objective of this job analysis was to assess the degree of similarity of the jobs of the submode operators. Given a high degree of similarity, a second objective was to describe the job elements characteristic of Aegis submodes in general. The third objective was to develop a job analysis method for obtaining information about natural sequences of job activities, and to use the method to describe such sequences in the operation of Aegis submodes. Finally, the analysis was intended to provide information about the educational and training requirements of Aegis submodes.

The present job analysis of Aegis submodes was preceded by another analysis (Shannon & Carter, 1981). That analysis was based upon the opinions of two job analysts who used the Position Analysis Questionnaire (PAQ Services, Logan, Utah, 84321) for analysis of the submode operator's job. According to its author (McCormick, 1979), the PAQ "is a structured job analysis questionnaire that provides for analyzing jobs in terms of 187 job elements. The elements are of a worker-oriented nature that tend to characterize, or to imply, the human behaviors that are involved in jobs." Information from a sample of PAQ's on 2,200 jobs from thoughout the world of work was used to generate some basic dimensions representing all occupations (McCormick, 1979). The earlier analysis by Shannon and Carter (1981) showed which of those dimensions were most characteristic of the Aegis submode jobs. The most important job elements of those characteristic dimensions were also identified. In the present analysis, incumbent submode operators responded to PAQ questions about job elements shown to be especially relevant to Aegis by the preceding job analysis. All submodes, except those related to anti-submarine warfare, were represented. The PAQ questions to which the incumbents responded were rewritten with Navy examples and assembled into a questionnaire (Appendix A).

METHOD

Aegis Questionnaire

The first section of the questionnaire consisted of four questions about training and educational requirements of Aegis submodes. It also included a question on the level of responsibility of the operator for the safety of others.

The second section of the questionnaire consisted of 31 PAQ questions found in a previous analysis (Shannon & Carter, 1981) to be especially relevant to Aegis submodes. Three 5-point scales were used by the incumbents to respond to each question. The first scale was the importance to the operation of the incumbent's submode of the job element described by the question. This is the

scale used on the PAQ. One additional scale was the frequency of the job element. Frequency could be high or low, independent of importance. A second additional scale was the difficulty of the job element. Difficulty of doing the element once could be high or low, independent of frequency or importance. The two additional scales were included to discover whether they could add anything to the information provided by the importance scale. It was reasoned that frequency and difficulty have implications for reliability, personnel selection, training, and equipment design that cannot be gleaned from the importance of the job elements.

The final section of the questionnaire solicited information about the sequence of job elements. For example, perhaps decision making is often followed by verbal communication. In order to show such sequences, numbers for each of the 31 job elements in the questionnaire were listed and followed by a blank. In the blank, the respondent was to put the number of the job element (if any) which usually followed the element being considered. This information was used to generate a job-element transition matrix to show the number, N_{ij}, of respondents indicating that element i was followed by job element j.

Respondents

The respondents were 16 incumbent submode operators with recent intense experience operating their submodes. Although this job analysis was planned to be as representative as possible of the Aegis submode operators' job, several characteristics of the respondents may limit the generalizability of the present results to other Aegis contexts. First, the incumbents were participants in a one-week training exercise. The job of learning to operate the Aegis submodes may be somewhat different from operation in a combat-ready status. Furthermore, the incumbents were a mixture of trainees and more experienced trainers, which may not be a typical situation. Also, the Aegis system operated by our respondents was unusual in that it was installed in a cruiser superstructure built on land for test and evaluation purposes. Finally, the present results may not be representative because of the artificial nature of the threat situation posed by frequent air sorties by friendly forces against the Aegis system trainer. These limitations of our data should be kept in mind when evaluating the results. Eight of the incumbents operated coordinator submodes (e.g., Anti Air Warfare Coordinator, Combat Systems Coordinator, Tactical Information Coordinator, Surface Warfare Coordinator, and Test Control Monitor), and the other eight were subordinate (Radar Systems Controller, Air Intercept Controller, Identification Supervisor, Air Control Supervisor, Missile Systems Supervisor, and Air Radar Controller). It seemed reasonable that if there were a difference in the job elements of the various submodes that it would show up most clearly in a contrast of coordinator and subordinate submodes.

Data from the earlier job analysis (Shannon & Carter, 1981) of Aegis submodes was available to be contrasted with data from the incumbents. This data will be used to answer the question of whether the job analysts and the incumbents had a similar interpretation of the job.

RESULTS

The results will be presented within the framework of several questions which motivated the analysis. Did incumbents give similar descriptions of their jobs? Did the job analysts and the incumbents agree in their description of the job? Can Frequency and Difficulty scales on a job analysis questionnaire add to information obtained from the usual Importance scale? What were the job elements which characterized the Aegis submodes? What are the typical sequences of job elements in operation of submodes? How much time have operators spent in formal education, training, and updating job knowledge?

Agreement Between Analysts and Incumbents, and Among Incumbents

Agreement between analysts and incumbents would be indicated if the same job elements were rated high or low by both analysts and incumbents. Such a condition is indicated by large correlations (near 1.0) among analysts' and incumbents' ratings. Table 1 shows the correlations among incumbents' and analysts' ratings. Ratings are compared from each of the two types of incumbents (coordinators and subordinates), for each of the three types of rating scales (frequency, importance, and difficulty). All these were also compared with the analysts' ratings of Aegis submodes, the naval career specialty of Operations Specialist, and a similar job performed by the Combat Information Control Officer aboard the E-2 advanced early warning aircraft.

There was a pattern of similarity between the incumbents' Difficulty ratings (columns 3 and 6) and the analysts' Importance ratings (rows 7, 8, and 9). The absence of large (near 1.0 correlations) in the last three rows of columns 2 and 5 of Table 1 indicates that the job analysts and the incumbents did not agree much on the relative importance of the job elements on this questionnaire. Some possible reasons for this lack of agreement are differences of interpretation of the importance scale by incumbents and analysts, differences in intended ratings of importance, or the fact that the anaysts were rating these 31 job elements in the context of the 187 elements of the PAQ whereas the incumbents were rating these 31 elements in isolation.

Principal components (PC) analysis of correlation tables like Table 1 often serve to highlight relationships like those discussed in the preceeding paragraph. Table 2 summarizes a PC analysis. The two factors listed in the table explain 75% of the standardized variability of the incumbents' and analysts' ratings. The first factor explains 43% of the variance, and factors beyond the second add no information. Factor 1 represents a strong relationship between coordinators' and subordinates' Frequency and Importance ratings. Factor 2 represents a strong relationship among the analysts' importance ratings of three jobs (Aegis, OS, and E-2). The incumbents' Difficulty ratings appear to be somewhat related to the analysts' Importance ratings.

Did the analysts agree with incumbents in their description of the job? The analysts appear to have given the same interpretation to Importance that the incumbents gave to Difficulty. This finding is difficult to explain.

Table 1
Correlation Matrix of Mean Task Analysis Questionnaire Ratings of Operators (on three scale types) and Job Analysts (for three positions)

			1	2	3	4	5	6	7	8	9
Frequency	(Command/Coord)	1	1.000								
Importanct	(Command/Coord)	2	.890	1.000							
Difficulty	(Command/Coord)	3	.373	.475	1.000						
Frequency	(Subordinate)	4	.773	.678	.089	1.000					
Importance	(Subordinate)	5	.662	.679	.177	.763	1.000				
Difficulty	(Subordinate)	6	.274	.341	.475	.390	.560	1.000			
Job Analyst	(Aegis)	7	-.108	.141	.483	-.038	.245	.595	1.000		
Job Analyst	(E2)	8	-.124	.060	.558	-.163	.186	.550	.804	1.000	
Job Analyst	(OS)	9	-.195	-.166	.449	-.226	-.053	.288	.525	.635	1.000

In contrast, the coordinator and subordinate incumbents appear to have almost complete agreement about the Frequency/Importance of the elements of their job. In no aspect of the results summarized in Tables 1 and 2 is it possible to differentiate the responses of incumbents in coordinator submodes from those of incumbents in subordinate submodes.

Table 2
Rotated Factor Loadings of Operators' Ratings (on 3 scales) and Job Analysts' Ratings (on 3 different positions)

			Factor 1	Factor 2
Frequency	(Com/Coord)	1	-.929	-.065
Importance	(Com/Coord)	2	-.902	.113
Difficulty	(Com/Coord)	3	.311	.693
Frequency	(Subordinate)	4	-.894	-.101
Importance	(Subordinate)	5	-.839	.205
Difficulty	(Subordinate)	6	.453	.674
Job Analyst	(Aegis)	7	.026	.881
Job Analyst	(E2)	8	-.061	.925
Job Analyst	(OS)	9	-.254	.756

If instead of considering correlations we consider the average ratings, coordinators rated their jobs higher in Frequency, Importance, and Difficulty than subordinates (the statistical test was $F(1,26) = 4.56$, $p = .04$). However, the pattern of average Frequency, Importance, and Difficulty ratings was the same for supervisors and subordinates ($F(2,52) = .21$, $P = .82$ for the rating scale by incumbent group interaction). All of this is sensible. The coordinator positions should be rated higher on Frequency, Importance, and Difficulty. The similarity of the pattern of ratings for coordinators and subordinates is further evidence that their jobs are similar in type, although different in degree.

To summarize, there is appreciable similarity between the jobs of the supervisory and subordinate submode operators. That similarity is primarily reflected by the Frequency and Importance rating scales. The analysts captured some of the aspects of the job described by the incumbents, but they appear to have interpreted the Importance scale like incumbents interpreted the Difficulty scale.

Relations Among the Frequency, Importance, and Difficulty Scales.

Tables 1 and 2 indicate that the Frequency and Importance scales conveyed very similar information, as interpreted by the incumbents. Perhaps job elements which were frequent were also important on each occasion they were done. Another possibility is that the description of the scales (see Appendix A) did not give the incumbents adequate information to differentiate Frequency from Importance. In any case, the scales were redundant in this application. If this finding were repeated then one of these scales might be deleted from such job analysis questionnaires.

The Difficulty scale was measuring something different from Frequency/ Importance in this analysis. There wasn't as much agreement between incumbent groups about the difficulty of various job elements in the questionnaire as there was about Frequency/Importance. Nonetheless, the Difficulty ratings were somewhat in agreement between incumbent groups. The aspect of the job measured by the Difficulty scale is indicated by the analysis of Table 2 to be unrelated to the aspect measured by the Frequency and Importance scales. Hence, the Difficulty scale seems to add information to the job analysis that was not available to the usual Importance scale. In contrast, the Frequency scale does not seem to add much new information.

Job Elements Which Characterize the Aegis Submodes

The job elements which characterize the submodes are the elements which received extreme ratings from the incumbents. Knowing which elements were rated high or low for frequency, importance, and difficulty should give one an understanding of the job. In addition, extreme-rated job elements should fall into certain patterns for optimum system performance. For example, elements that occur with high frequency should be of low difficulty if the system is to perform reliably. Frequent, difficult elements are areas of possible system improvement. Elements related to equipment use should have low difficulty if the equipment is properly designed and used. Furthermore, elements which are frequent and important may suggest traits of successful operators. Operators with these traits may be obtained by training or by personnel selection.

Table 3 displays the elements of the Aegis submode operator's job which received extreme ratings. The elements are listed separately in order of Frequency, Importance, and Difficulty ratings. Of course, the extreme ratings would not be of interest if there were little spread of the ratings, or little agreement among the incumbents. These factors were taken into account in a statistical (Newman-Keuls) procedure, and the elements listed in Table 3 are those that have ratings that are dispersed beyond mere chance difference from at least one other element at the opposite extreme of the rating scale. The Newman-Keuls procedure (Kirk, 1968) is constructed so that considering all pairs of ratings within one scale the chance of incorrectly declaring any two of the ratings to be different is less than 5 in 100.

Study of Table 3 reveals some interesting patterns. For instance, use of the foot-operated communication switch was rated as the most frequent element, and also as the least difficult. This type of result indicates good design of the man-machine interface. This is also indicated by the low difficulty rating

Table 3: Job elements with High or Low Ratings*

Rating Scales

	Frequency	Importance	Difficulty
(highest)	24. Use of foot operated controls (4.4)	23. Use of activation controls (4.3)	20. Working under distractions (2.9)
	23. Use of activation controls	4. Use of verbal information	
	28. Advising others (4.3)	19. Attending to detail	
	29. Routine comms/not advising	24. Use of foot-operated control (3.7)	
	4. Use of verbal information	29. Routine comms/not advising	
	20. Working under distractions	25. Use of trackball	
High	7. Monitoring events (3.4)	7. Monitoring events	
	19. Attending to detail	9. Decision making (3.6)	
	1. Use of quantitative visual information	6. Watching for infrequent events	
	5. Recognition of objects, events, processes	5. Recognition of objects, events, processes	
	9. Decision making	20. Working under distractions	
	6. Watching for infrequent events (3.0)	18. Responding under time pressure (3.2)	
(lowest)	27. Writing (1.1)	27. Writing (1.1)	24. Use of foot operated controls (1.0)
	17. Use of mathematics	2. Use of visual information about natural features	25. Use of trackball
	2. Use of visual information about natural features	17. Use of mathematics	27. Writing (1.3)
	10. Reasoning (1.6)	15. Copying or transcribing	
	11. Planning and scheduling	10. Reasoning (2.0)	
	15. Copying or transcribing		
	13. Analyzing information		
	25. Use of trackball		
Low	30. Non-routine communication		
	22. Use of keyboard devices (2.3)		

*Elements included in this table were rated statistically significant higher or lower ($P < .05$) than at least one other job element in the same rating scale. Mean ratings on a 5-step scale are given in parentheses for marker elements. In this table, each element description is preceded by its number from our questionnaire (Appendix A).

of trackball use, and writing. Working under distractions is a frequent, difficult element which may be a key to further system improvement. Further work might be done to find out what types of distractions are being referred to, and what might be done to reduce their frequency and difficulty. If we turn our attention to the apparent demands of the task, we find that the frequent, important job elements heavily involve communication (advising, routine communications/not advising, use of verbal information, use of foot-operated controls (communication switch)). The watchstander's duties of monitoring events, recognition of events, and decision making were also rated high on Frequency and Importance. A third area of task demand is the conflicting elements of attending to detail and working under distractions. It is remarkable that mental operations such as analyzing information, reasoning, use of mathematics, and planning and scheduling are relatively infrequent and unimportant in this job. These findings may be related to the limitations, described earlier, of the data. They should be reexamined if an opportunity arises to analyze the job of Aegis submode operators in a more typical context. In general, Aegis submode operators could be selected or trained for efficient communication, alert watchstanding, and ability to attend to detail while working under distractions.

Typical Sequences of Action in Operation of Aegis Submodes

The job element part of the questionnaire provided valuable information about what is done on the job, but it tells us little about when it is done. The sequence of job elements can also be useful information. For example, knowing the sequence of job elements can aid an equipment designer to configure displays and controls so that temporally adjacent job elements involve spatially adjacent equipment. Training is likely to be more effective if it includes elements of the job in the correct sequence indicated by job analysis. Finally personnel tests should be more job-related if they include the actual timing of elements of the job.

Seven of the sixteen incumbents reponded to the last part of the questionnaire, which dealt with natural sequences of job elements of Aegis submode operation. The incumbents indicated which, if any, job element typically followed each other element. The data were cast in the form of a matrix. Table 4 shows the number ,N_{ij}, of times the respondents said that element j (matrix column) was followed by element i (matrix row). The matrix showed that two elements often follow a wide variety of other elements. The two common end points of many element sequences were: element 23, "use of activation controls (e.g., VAB)" and element 4, "use of (non visual) verbal information related to the job (e.g., verbal instructions, orders, requests, etc. that are relevant to the job)". A common beginning for sequences was element 1, "use of visual information that tells you how much of something there is or should be". Two common transitions were to element 23 from elements 1 or 9, "decision making: choosing from among a variety of alternatives, taking into consideration the consequences of the choice". These action sequences are depicted in Figure 1.

This information suggests some practical actions. The transition from element 1 to element 23 suggests that quantitative visual displays should be located next to appropriate activation controls, so that it would be easy to shift attention from one to the other. Furthermore, training should involve the sequences of elements discussed.

Table 4: Number of Times Respondents Indicated a Sequence of Actions to be Typical

	Item Number of First Action																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1																						1									
2																											1				
3																							1								
4	1	1	1		1	1	1		1			1	1	1		1	1		1	1			1	1	1			2			
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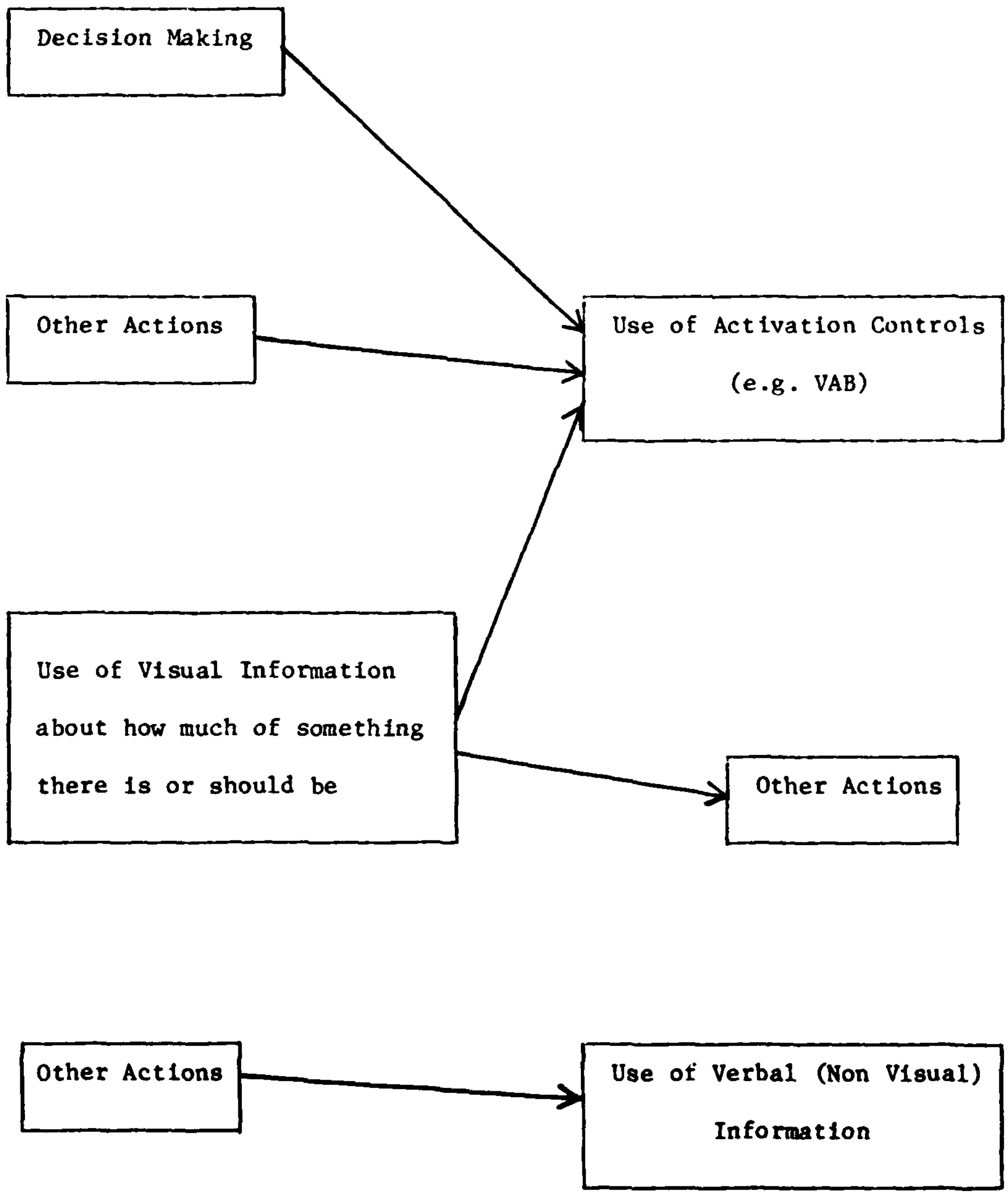
Figure 1: Commonly Occuring Action Sequences



The poor response rate to this part of the questionnaire (only 7 of 16 incumbents responded) indicates that it needs to be reworded to make responding easier. The information obtained about typical action sequences appears to be worthwile.

Education, Training, and Updating of Aegis Submode Operators

Questions 2, 3, and 4 of the questionnaire measures incumbents' perceptions regarding education, experience, and training. Figure 2 shows the frequency distribution of responses to question 2 regarding the level of formal education the operators believed was necessary to operate their submode. The mean was 12 years with a standard deviation of 3.87 years. The distribution was negatively skewed due to one subject who responded that formal education was unnecessary. In general, though, the operators thought that at least a high school education was required and some felt some post-high-school preparation was necessary. As Figure 2 indicates, the subordinates were somewhat more varied in their opinions than were the coordinators, although this could be due to the smaller number of respondents for that group.

In terms of on-the-job training and experience thought necessary (question 3), the operators were extremely variable in their responses with a mean period of 7.88 weeks of training and a standard deviation of 6.72 weeks (see Fig 3). The variability in this response could be due to several sources such as variability in the difficulty/complexity of the various positions and/or differences in ability of the subjects. The operators perceived an average of 9.75 hours spent per month in studying operating procedures, doctrine, etc., as necessary to be a proficient operator, with a standard deviation of 3.12 hrs. (see Figure 4). Due to the free response format of this item, the information cannot be as neatly summarized as the other items. The variability in responses to this question seemed to be related to situational factors that went unspecified in most of the respondents' answers.

Even disregarding the few highly atypical responses, the profiles on questions 3 and 4 (see Figures 3, 4) suggests, most strongly, that the operators are either highly variable in the ability they bring to the position, or the positions themselves are rather variable in their related demands. This latter idea may have some merit, since the correlations between operator groups were as low as .475 (for difficulty); not a poor correlation but still not accounting for a large amount of variance of difficulty.

Safety

The answer to question 5 regarding what degree the safety of others depends on correct action of the operators varied from 'none in this environment' to 'critical, depending on the environment and ship situation'. The safety implications of action by submode operators appear to be widely variable.

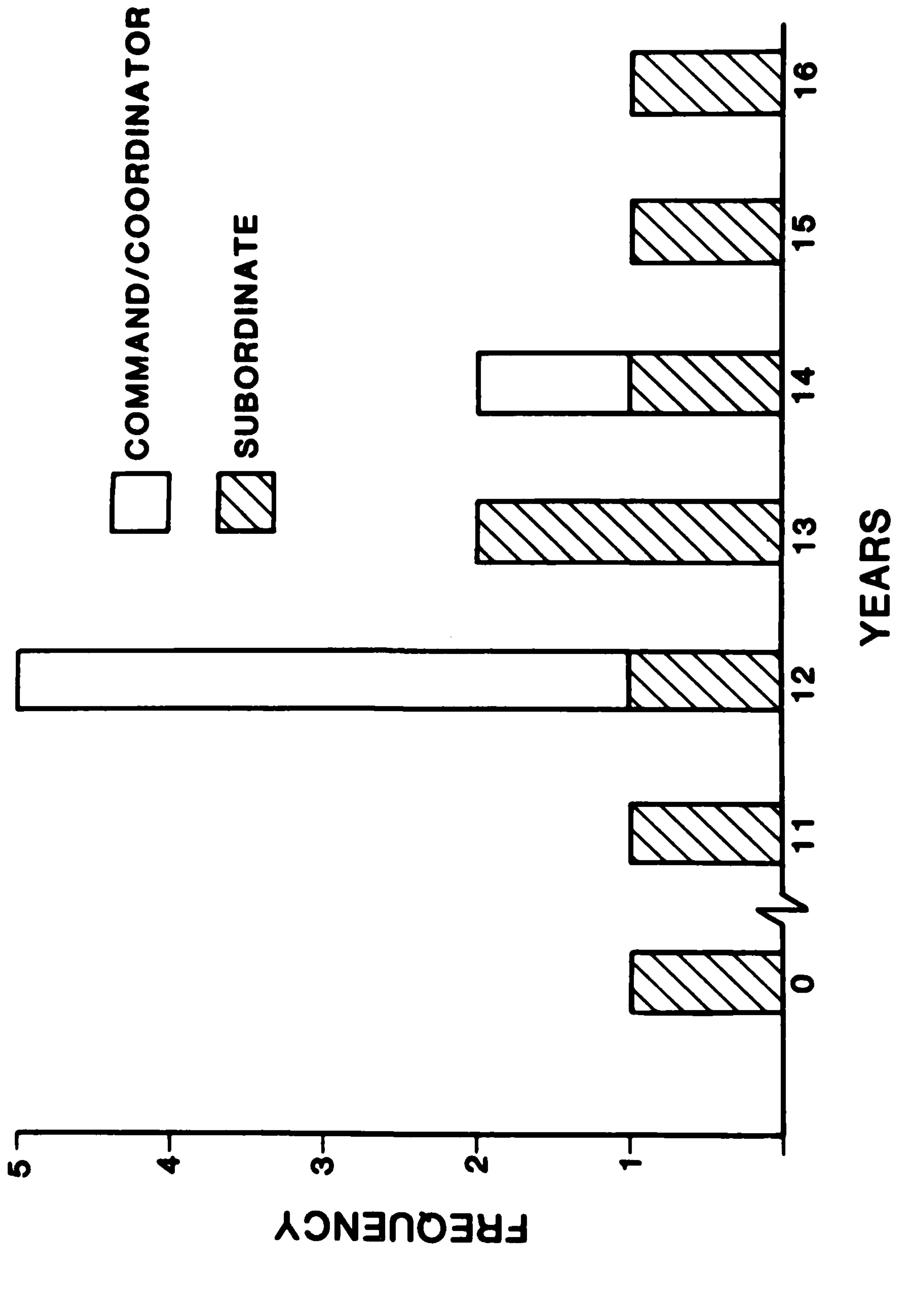


FIG 2 EDUCATION REQUIRED FOR AEGIS SUBMODE OPERATORS (12 YRS:HIGH SCHOOL)

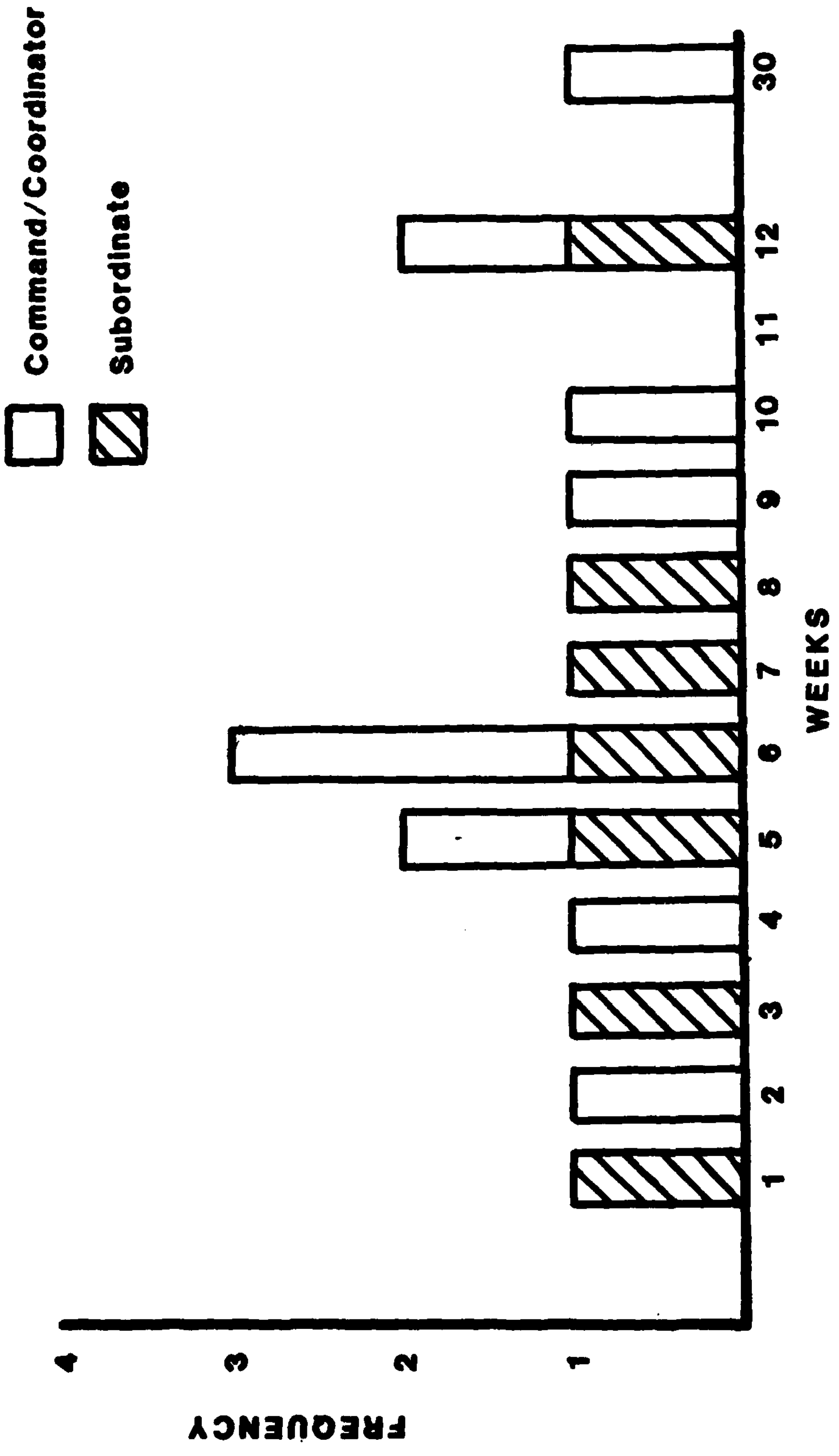


FIG 3 FREQUENCY OF RESPONSES OF OPERATOR PERCIEVED TRAINING AND ON THE JOB EXPERIENCE NECESSARY FOR OPERATOR PROFICIENCY (Ques. #3) n=16

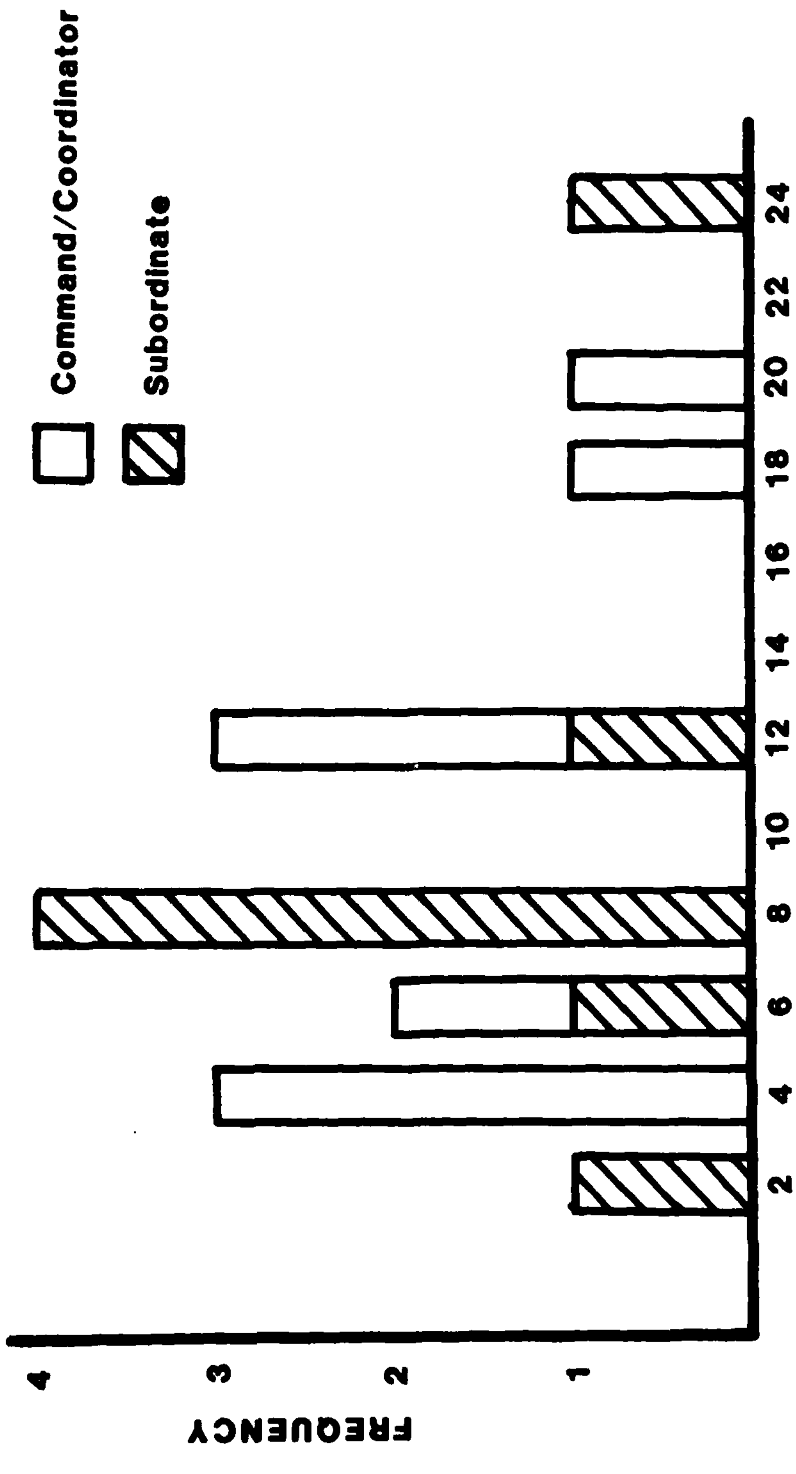


FIG 4 FREQUENCY OF RESPONSES OF OPERATOR PERCIEVED TIME NEEDED FOR UPDATING JOB KNOWLEDGE (Ques.#4) n=16

Summary

A job-analysis questionnaire was responded to by 16 incumbent Aegis submode operators. Their responses were the basis for analyses related to commonality among submodes, job elements and sequences typical of submode operation, and the educational and training requirements of the submodes. It is concluded that there is considerable commonality among the submodes. Job elements typical of submode operation involve communication, alert watchstanding, and attending to detail while working under distractions. Typical sequences of job elements end with the use of activation controls (e.g., VAB), or verbal orders/instruction/requests, preceded by use of visual displays or decision making without reference to an external information source. Educational requirements for submode operation were a high-school education, on the average. Training time was extremely variable with a mean of about eight weeks. About 10 hours of study per month was perceived to be necessary to maintain proficiency in operating procedures, doctrine, etc.

Implications for Performance Testing under Environmental Stress

Although a job analysis such as this one can have many uses, the authors' primary concern was to learn something about a critical job in the Navy so that human performance experiments could be made more relevant to performance in the fleet. Our human performance research is being done at the Naval Biodynamics Laboratory, which has facilities for carefully controlled simulations of ship motion (heave), vibration, and crash impact. We would like to show what aspects of human performance are affected by these environmental stressors, and which are not. For example, the best evidence is that ship motion can affect the speed and accuracy of continuous whole-arm movements (an effect which is independent of nausea); vibration can effect visual resolution and fine manual facility; and crash impact can affect overall responsiveness, and memory. Whether or not these findings are useful to the Navy depends upon the extent to which Navy jobs require the affected skills and abilities. For instance, Aegis submode operation would be adversely affected by stressors which interfere with the most characteristic job elements and job sequences of submode operation. Characteristic job elements are: use of foot operated controls, use of activation controls (such as pushing a VAB with a continuous whole-arm movement), use of verbal information, advising others, attending to details, and routine communication. A characteristic sequence involves use of visual information or decision making, followed by use of activation controls. Conversely, Aegis submode operation should be little affected by stressors which interfere with relatively infrequent and unimportant elements such as writing, use of mathematics, reasoning, or use of visual information about natural features. This information will help us to design our human performance experiments for maximum relevance to the fleet.

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APPENDIX A
AEGIS SUBMODE QUESTIONNAIRE

AEGIS SUBMODE QUESTIONNAIRE

1. Which submode do you operate? ______________________________

2. What level of formal education is needed to operate this submode?
______________ years.

3. Given the needed amount of formal education, how much training and on-the-job experience does an operator need to become proficient?
______________ weeks.

4. How much time, if any, must the proficient operator spend undating job knowledge (e.g., studying operating procedures, doctorine, etc.)?
______________ hrs. per month.

5. To what degree does the safety of others depend on correct action of the operators?

____

____

____

____

____

____

Please rate the following actions in terms of:

* How frequently they apply to operation of this submode.

* Importance to mission success, without regard to frequency.

* Difficulty of one instance of the action. This is the typical amount of attention and effort required to accomplish the action once, using this submode. Rate the difficulty of accomplishing the action once; do not consider frequency. Difficulty is related to complexity of an action or the amount of training required to perform it.

Use the following five-point scales to rate each item RELATIVE TO ALL OTHER ITEMS. For example, every action may be of critical importance, but some are more critical than others in operation of this submode. An action that is more critical than about half of all actions would be rated 3 on the importance scale, indicating moderate importance relative to other actions.

I. Frequency relative to other items on this inventory

0 - Does not apply
1 - Very infrequent
2 - Occasional
3 - Moderate
4 - Often
5 - Very often

II. Importance to mission success, without regard to frequency

0 - None (no impact on mission success)
1 - Little
2 - Some
3 - Moderate
4 - High
5 - Critical (Success of the mission depends upon correct action)

III. Average difficulty, without regard to frequency

0 - Done without noticing
1 - Easy (Can be done while doing other things)
2 - Slightly difficult
3 - Moderately difficult
4 - Difficult (requires undivided attention and/or effort)
5 - Very difficult (complex action, possibly requiring much experience and/or training)

Input to Operator	Frequency	Importance	Difficulty
1. Use of visual information that tells you how much of something there is (or should be)(e.g., number of missiles in a magazine)	______	______	______
2. Use of visual information about natural features (e.g., weather, land, sea)	______	______	______
3. Use of visual information about man-made features (e.g., ships, cities, aircraft)	______	______	______
4. Use of (non visual) verbal informaton related to the job (e.g., verbal instructions, orders, requests, etc. that are relevant to the job)	______	______	______
5. Recognition of objects, events, or processes (e.g., recognizing a situation as described in the doctorine)	______	______	______
6. Watching for infrequent events (e.g., equipment failure)	______	______	______
7. Monitoring continually changing events (e.g., the deployment of hostile and friendly forces)	______	______	______
8. Other actions typical of this submode that come before mental processing and response. Specify:			
______________________	______	______	______
______________________	______	______	______
______________________	______	______	______
______________________	______	______	______
______________________	______	______	______
______________________	______	______	______

Mental Processing of Combat Information	Frequency	Importance	Difficulty
9. Decision making: choosing from among a variety of alternatives, taking into consideration the consequences of the choice (e.g., initiating an attack)	______	______	______
10. Reasoning: problem solving by using rules or principles to draw conclusions (e.g., using the three-minute rule)	______	______	______
11. Planning and scheduling (planning the order of engaging elements of a hostile force)	______	______	______
12. Combining information from multiple sources (e.g., integrating multi-sensor information)	______	______	______
13. Breaking down information into component parts to find underlying principles or facts (e.g., analyzing an EW signal)	______	______	______
14. Gathering, grouping, classifying, or otherwise arranging information (e.g., grouping contacts as to probable ship or aircraft types)	______	______	______
15. Copying or transcribing information (e.g., writing down a vergal transmission)	______	______	______
16. Recalling, after a brief time, information that was memorized while doing the job (e.g., remembering the location of various contact numbers)	______	______	______
17. Using mathematics such as counting, arithmetic, fractions, geometry, trigonometry, algebra, etc. (e.g., counting the number of neutral aircraft, or solving a relative motion problem)	______	______	______

18. Responding under time pressure (urgent deadlines, rush jobs) ______ ______ ______

19. Attending to detail, making sure nothing is left undone ______ ______ ______

20. Working under distractions (interruptions, two things requiring attention at once) ______ ______ ______

21. Other aspects of mental processing of Combat Information. Specify:

____________________ ______ ______ ______
____________________ ______ ______ ______
____________________ ______ ______ ______
____________________ ______ ______ ______
____________________ ______ ______ ______
____________________ ______ ______ ______

<u>Output from Operators</u>

22. Use of keyboard devices ______ ______ ______

23. Use of activation controls (e.g., VAB) ______ ______ ______

24. Use of foot operated controls ______ ______ ______

25. Use of trackball ______ ______ ______

26. Use of other controls. Specify:

____________________ ______ ______ ______
____________________ ______ ______ ______
____________________ ______ ______ ______
____________________ ______ ______ ______
____________________ ______ ______ ______
____________________ ______ ______ ______

27. Writing (e.g., making log entries) ________ ________ ________

28. Advising others (e.g., counseling or guiding others for the purpose of solving problems) ________ ________ ________

29. Routine job-related communication (other than advising) (e.g., communication in standard format and vocublary) ________ ________ ________

30. Non-routine job-related communication (other than advising) (e.g., communication that requires deviation from standard format and vocabulary) ________ ________ ________

31. Other operator output. Specify:

________________________________ ________ ________ ________
________________________________ ________ ________ ________
________________________________ ________ ________ ________
________________________________ ________ ________ ________
________________________________ ________ ________ ________
________________________________ ________ ________ ________

Please indicate common sequences of actions by using action numbers 1-31 from the preceding part of this questionnaire. Below are listed the numbers 1-31 to represent the first action in a sequence. If operation of your sub-mode often requires following one of these actions with a second action, please write the number of the second action after the number of the first action. For example, if after making a decision (action 9) you often press a VAB (action 23), then mark 23 after the number 9 below.

1	_____	9	_____	17	_____	25	_____
2	_____	10	_____	18	_____	26	_____
3	_____	11	_____	19	_____	27	_____
4	_____	12	_____	20	_____	28	_____
5	_____	13	_____	21	_____	29	_____
6	_____	14	_____	22	_____	30	_____
7	_____	15	_____	23	_____	31	_____
8	_____	16	_____	24	_____		

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